Amendments to the Specification:

Please replace paragraph 3 with the following rewritten paragraph:

Traffic signals should appear bright over a wide range of viewing angles. In the past, the use of light emitting diodes (~~LED's~~ LEDs) for such applications has been limited due to the high degree of directionality of the LED light source which restricts the effective viewing angle to angles relatively near to normal incidence. The prior art discloses use of an external lens to spread the LED light and increase the effective viewing angle. Because of the large amount of light refraction required to convert the highly directional LED light output to a more uniform beam output, conventional thick lenses are not appropriate. Instead, the prior art discloses using Fresnel lenses for this purpose. However, the use of Fresnel lenses for LED traffic signal lights has the disadvantage of typically reducing system efficiency by at least ten percent due to Fresnel losses in the lens.

Please replace paragraph 5 with the following rewritten paragraph:

In accordance with one embodiment of the present invention, a lighting apparatus is disclosed. A wave guide has microstructures arranged on a surface thereof. The microstructures interact with light in the wave guide to scatter at least a portion of the light out of the wave guide in a pattern. The pattern is determined by the arrangement of the microstructures. A plurality of light emitting diodes ~~are~~ is coupled to the wave guide and ~~inject~~ injects light into the wave guide.

Please replace paragraph 11 with the following rewritten paragraph:

In accordance with another aspect of the present invention, the wave guide defines a planar region. The plurality of light emitting diodes ~~are~~ is arranged around at least a portion of a perimeter of the planar region and ~~inject~~ injects light into the planar region of the wave guide.

Please replace paragraph 15 with the following rewritten paragraph:

In accordance with another embodiment of the present invention, an optical wave guide for use in conjunction with an associated light source is disclosed. A translucent material is formed into a shape having a top surface, a non-parallel bottom surface, and at least one side surface in optical communication with the associated light source. A plurality of microstructures ~~are~~ is disposed about the bottom surface. The plurality of microstructures ~~cooperate~~ cooperates with the bottom surface to scatter at least a portion of light injected from the associated light source. The scattered light exits the wave guide through the top surface.

Please replace paragraph 17 with the following rewritten paragraph:

In accordance with another aspect of the present invention, the plurality of microstructures ~~include~~ includes a surface roughness or texture formed into the bottom surface.

Please replace paragraph 30 with the following rewritten paragraph:

With reference to FIGURE 1, a first embodiment of the invention is described. A lighting apparatus **10** includes a substrate **12** which is essentially planar. An optical wave guide **14**, also essentially planar, is formed from a translucent material and is affixed to the substrate **12** using an adhesive, fasteners, or other means (not shown). The essentially planar optical wave guide **14** can be of any geometric shape, such as a circle, an oval, or a rectangle. In FIGURE 1 the wave guide **14** is shown as a rectangle with rounded corners. A plurality of light emitting diodes (~~LED's~~ LEDs) **16** ~~are~~ is mounted on the substrate **12** and ~~surround~~ surrounds the perimeter **18** of the wave guide **14**. The ~~LED's~~ LEDs **16** are mounted approximately at right-angles to the essentially planar wave guide **14** so that light generated by the ~~LED's~~ LEDs **16** is injected into the wave guide **14**. A refractive index-matching material **20** advantageously is disposed between the wave guide **14** and the ~~LED's~~ LEDs **16**.

The index matching material **20** optionally also serves as an encapsulant for the ~~LED's~~ LEDs **16**, so that a sealed unitary structure comprising the wave guide **14** and the plurality of ~~LED's~~ LEDs **16** is formed. Such a sealed unitary structure is advantageously essentially weatherproof and can be manufactured and utilized without external containment or lenses. The top surface of the wave guide **14**, or a selected portion thereof, can be directly exposed without a lens or other covering. The lighting apparatus **10** also preferably includes an opaque coating or covering (not shown) that blocks the ~~LED's~~ LEDs **16** from being directly viewed.

Please replace paragraph 32 with the following rewritten paragraph:

With continuing reference to FIGURE 1, further reference is now made to FIGURE 2, which shows a sectional view of the lighting apparatus **10** taken along the Section **S-S** indicated in FIGURE 1. The wave guide **14** includes an essentially planar light-emissive face or top surface **30**, a bottom surface **32** that has a pre-defined slope or curvature, and at least one side surface **34**. In the illustrated embodiment, the side surface follows the perimeter **18** of the wave guide **14**, around which the ~~LED's~~ LEDs **16** are arranged. In the embodiment shown in FIGURE 2, the pre-defined curvature of the bottom surface **32** of the wave guide **14** includes a surface tilt of angle ϕ with respect to the plane of the wave guide **14**, i.e. with respect to the essentially planar substrate **12**. Other curvatures, such as parabolic or discontinuous (e.g., stepped) curvatures, are also contemplated for the curvature of the bottom surface **32**. The bottom surface **32** also includes a plurality of microstructures **36** disposed on selected areas of the inside of the bottom surface **32**.

Please replace paragraph 33 with the following rewritten paragraph:

In operation, light **38** generated by the ~~LED's~~ LEDs **16** is coupled or injected into the at least one side surface **34** substantially along an axis **40** which lies at a right angle to the top surface or emissive face **30**. The optical coupling is enhanced by the refractive index-matching material **20** that reduces reflection losses at the side surface **34**. The injected light

38 is advantageously confined within the wave guide **14** by total internal reflection as is well known to those skilled in the art. However, the microstructures **36** that are disposed on selected areas of the bottom surface **32** act as scattering centers that scatter the guided light **38**. At least a portion of the injected light **38** is converted into scattered light **42** through interaction with the microstructures **36** on the bottom surface **32**, and at least a portion of the scattered light **42** is scattered toward the top light-emissive surface **30** of the wave guide **14**. That portion of the scattered light **42** that encounters the top surface **30** at an angle (respective to the surface normal of the top surface **30**) that is less than the critical angle for total internal reflection at the surface **30** exits the wave guide **14** through the top surface **30** as the visible light emission of the lighting apparatus **10**.

Please replace paragraph 35 with the following rewritten paragraph:

With continuing reference to FIGURES 1 and 2, in one embodiment the plurality of microstructures **36** ~~are~~ is arranged on selected areas of the bottom surface **32**. In FIGURE 1, the microstructures **36** are arranged to display a combination of symbols **50** corresponding to the word "WALK". Thus, the embodiment of FIGURE 1 is suitable for a pedestrian "WALK" signal. Because the light **38** is scattered only off the selected areas that are covered by the microstructures **36**, the arrangement of microstructures **36** shown in FIGURE 1 that forms the symbol combination "WALK" **50** produces a corresponding light output pattern of the lighting apparatus **10** that appears to an associated viewer as "WALK". Because the scattered light **42** is viewed, rather than the direct LED radiation **38**, the text is readable at large viewing angles.

Please replace paragraph 37 with the following rewritten paragraph:

With reference now to FIGURE 3, another embodiment **110** of the lighting apparatus is described. Rather than defining a selected symbol or combination of symbols, in the embodiment of FIGURE **110** the plurality of microstructures **36** ~~are~~ is uniformly distributed across the bottom surface of a circular wave guide **114** to form a uniform light output beam by wave guide mixing that is viewable at large angles. The color produced by the lighting

apparatus **110** can be established by using selected ~~LED's~~ LEDs **116** that emit light of the selected color, e.g. red, yellow, or green ~~LED's~~ LEDs. In another embodiment, the ~~LED's~~ LEDs **116** are white ~~LED's~~ LEDs and the wave guide **114** is appropriately tinted to produce a selected color. The latter variant has the benefit of using standardized white ~~LED's~~ LEDs **116** throughout.

Please replace paragraph 41 with the following rewritten paragraph:

Although the invention has been described with particular reference to traffic signal applications, it will be appreciated by those of ordinary skill in the art that the invention is not so limited, but rather will also find application in general illumination, such as in desk lamps and illuminated magnifying glasses, where spatially and angularly uniform light output is desirable. For example, the lighting apparatus embodiment **110** of FIGURE 3 is suitable as the light source for a desk lamp, for room illumination, and the like. In an alternate embodiment, the invention will find application in light mixing applications. Considering again the embodiment **110** of FIGURE 3, the plurality of ~~LED's~~ LEDs **116** can optionally include two or more different types of ~~LED's~~ LEDs, e.g. a sub-set of blue ~~LED's~~ LEDs and a sub-set of yellow ~~LED's~~ LEDs (not shown). By selectively operating one or the other sub-set of ~~LED's~~ LEDs, the lighting apparatus so modified can produce either blue light or yellow light. Additionally, by operating both the blue sub-set and the yellow sub-set of ~~LED's~~ LEDs simultaneously, the wave guide **114** serves as a light mixing component and green light (the color combination resulting from mixing blue and yellow light) is produced. Using this approach, the three red, yellow, and green signal lights of a conventional traffic control signal can be effectuated by a single lighting apparatus (not shown) having red, yellow, and green sub-sets of ~~LED's~~ LEDs, thus enabling a more compact traffic control signal light. Of course, such color combinations and light mixing can also be applied to symbolic lights such as the lighting apparatus **10** shown in FIGURE 1. For example, the "WALK" signal light of FIGURE 1 could be modified to include a white lighting condition for the initial portion of the walk cycle, followed by a reddish lighting condition that signifies that the end of the cycle

is nearing. Of course, the ~~LED's~~ LEDs can also be blinked on-and-off or otherwise intensity-modulated to provide an indication of the nearness of the end of cycle.

Amendments to the Claims:

Please amend the claims as follows:

1. (Original) A lighting apparatus comprising:

a wave guide having microstructures arranged on a surface thereof, said microstructures interacting with light in the wave guide to scatter at least a portion of the light out of the wave guide in a pattern, the pattern being determined by the arrangement of the microstructures; and

a plurality of light emitting diodes that ~~are~~ is coupled to the wave guide and ~~inject~~ injects light into the wave guide.

2. (Original) The lighting apparatus as set forth in claim **1**, wherein:

the pattern includes at least one of a letter, a numeral, an arrow, an iconic image of a walking man, an iconic image of a hand, an iconic image of a circle with a slash drawn there through, an iconic image indicating "pedestrian don't walk", and an iconic image indicating "pedestrian walk".

3. (Currently Amended) The lighting apparatus as set forth in claim **1**, wherein the pattern further comprises:

light scattered at wide angles, ~~which light is viewable at a wide range of viewing angles~~ said light scattered into wide angles by the microstructures, said light being viewable at a wide range of viewing angles.

4. (Original) The lighting apparatus as set forth in claim **1**, further comprising:

a cladding comprising one of a surface coating and a cladding material, said cladding being disposed on the surface on which the microstructures are disposed, said cladding cooperating with the microstructures to effectuate the light scattering.

5. (Original) The lighting apparatus as set forth in claim **1**, wherein the wave guide further includes:

a tinting whereby the scattered light has a pre-selected color.

6. (Original) The lighting apparatus as set forth in claim **1**, wherein:

the surface on which the microstructures are arranged has a pre-selected curvature.

7. (Currently Amended) The lighting apparatus as set forth in claim **1**, wherein:

the wave guide defines a planar region; and

the plurality of light emitting diodes ~~are~~ is arranged around at least a portion of a perimeter of the planar region and ~~inject~~ injects light into the planar region of the wave guide.

8. (Original) The lighting apparatus as set forth in claim **7**, wherein:

at least a portion of the surface on which the microstructures are arranged is tilted with respect to the plane of the planar region such that the tilt cooperates with the microstructures and the plurality of light emitting diodes to effectuate the scattering of the light in the pre-determined pattern.

9. (Currently Amended) The lighting apparatus as set forth in claim **1**, further comprising:

~~an~~ a refractive index-matching material disposed at least between the plurality of light emitting diodes and the wave guide.

10. (Cancelled) The lighting apparatus as set forth in claim **1**, wherein the plurality of light emitting diodes includes:

a first sub-set of light emitting diodes emitting light having a first color; and

a second sub-set of light emitting diodes emitting light having a second color that mixes with the first color in the wave guide to produce a third color.

11. (Currently Amended) An optical wave guide for use in conjunction with an associated light source, the optical wave guide comprising:

a translucent material formed into a shape having a top surface, a ~~non-parallel~~ substantially spherical bottom surface, and at least one side surface in optical communication with the associated light source; and

a plurality of microstructures disposed selectively about the bottom surface, said plurality of microstructures cooperating with the bottom surface to scatter at least a portion of light injected from the associated light source, the scattered light exiting the wave guide through the top surface.

12. (Original) The optical wave guide as set forth in claim **11**, wherein the scattered light forms a pre-selected light output pattern viewable outside the wave guide.

13. (Currently Amended) The optical wave guide as set forth in claim **11**, wherein the plurality of microstructures ~~include~~ includes a surface roughness or texture formed into the bottom surface.

14. (Original) The optical wave guide as set forth in claim **11**, further comprising:

a cladding material disposed on the outside of the bottom surface that cooperates with the plurality of microstructures to effectuate the light scattering.

15. (Cancelled) A lighting apparatus comprising:

a light emissive face including a textured surface; and

a plurality of light producing elements arranged about a periphery of the light emissive face, the light producing elements producing light substantially along an axis orthogonally disposed relative to the light emissive face, wherein light interacting with the textured surface is emitted from the light emissive face.

16. (Currently Amended) ~~The~~ A lighting apparatus ~~as set forth in claim 15~~ including:

a light emissive wave guide including a textured surface ~~wherein the light emissive face defines~~ and defining a center and a perimeter, ~~where~~ wherein a thickness of the light emissive ~~face~~ wave guide at the perimeter is greater than a thickness of the light emissive ~~face~~ wave guide at the center; and

a plurality of light producing elements arranged around a perimeter of the light emissive wave guide, the light producing elements producing the light substantially along an axis orthogonally disposed relative to the light emissive wave guide, wherein the light interacting with the textured surface is emitted by the light emissive wave guide.

17. (Currently Amended) The lighting apparatus as set forth in claim ~~15~~ 16, further comprising an encapsulant surrounding the plurality of light producing elements and abutting the light emissive ~~face~~ wave guide, the encapsulant matching a refractive index of the light emissive ~~face~~ wave guide.

18. (Currently Amended) The lighting apparatus as set forth in claim ~~15~~ 16, ~~where~~ wherein the textured surface forms a symbol.

19. (Currently Amended) The lighting apparatus as set forth in claim ~~15~~ 16, ~~where~~ wherein the textured surface comprises a plurality of microstructures arranged in a pattern on an interior side of the light emissive ~~face~~ wave guide.

REMARKS

This amendment is responsive to the communication of February 27, 2003. Reconsideration of claims 1-9, 11-14 and 16-19 is respectfully requested.

The Office Action

The drawings were objected to as failing to show every feature of invention.

Claims 3 was objected to because of the informalities.

Claims 1, 2, 4, 7, 15 and 18-19 stand rejected under 35 U.S.C. § 102(e) as being anticipated by Maas (U.S. Patent Publication US 2001/0049893 A1).

Claims 11, 12 and 13 stand rejected under 35 U.S.C. § 102(b) as being anticipated by Simms (U.S. Patent No. 5,590,945).

Claim 3 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Maas (U.S. Patent Publication US 2001/0049893 A1).

Claim 5 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Maas (U.S. Patent Publication US 2001/0049893 A1) in view of Tokunaga (U.S. Patent No. 5,375,043).

Claims 6 and 8 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Maas (U.S. Patent Publication US 2001/0049893 A1) in view of Yamana (U.S. Patent No. 5,418,384).

Claim 9 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Maas (U.S. Patent Publication US 2001/0049893 A1) in view of Lin (U.S. Patent No. 6,464,366).

Claim 14 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Simms (U.S. Patent No. 5.590,945) in view of Maas (U.S. Patent Publication US 2001/0049893 A1).

Claims 10 and 15 have been cancelled.

Objections to the Drawings

Objections to the drawings have been alleviated by the amendments to the claims. It is respectfully requested that the objections to the drawings be withdrawn.

Non-Art Amendments

The specification has been amended to correct minor mistakes. The amendments to the specification do not represent any new matter.

The Examiner's objections to informalities in **claim 3** have been addressed by the amendments. It is respectfully requested that these objections be withdrawn.

Prior Art Rejections

Claims 1, 2, 4, 7, 15, 18 and 19 are rejected as being anticipated by Maas. Applicant submits herewith a Declaration under 37 CFR §1.131. The Declaration evidences conception of the invention before the effective date of Maas with diligence to a constructive reduction to practice. Accordingly, withdrawal of the rejection is respectfully requested.

Claims 11, 12, and 13 are rejected as being anticipated by Simms. **Claim 11** calls for a substantially spherical bottom surface and a plurality of microstructures selectively disposed about the bottom surface. The microstructures cooperate with the bottom surface to scatter a portion of the light injected from the associated light source. Simms discloses the bottom surface that structured with ridges disposed uniformly on two arcuate portions. A patterned effect may be achieved by making portions of the front viewing surface of the light guide opaque or semi-transparent. Thus, Simms discloses that a patterned light might be achieved by blocking some of the light on the top surface of the structure. Simms can not achieve selective scattering of the light off the bottom surface since the ridges are positioned uniformly. In contrast, claim 11 teaches to position the microstructures selectively based on the particular symbol that needs to be displayed. The patterned light design is achieved by scattering light off the microstructures, not manipulating the top surface. Furthermore, the geometry of the bottom surface shape is solitary and spherical. Simms discloses that bottom surface includes two arcuate parts. Neither Simms, nor a combination of the references discloses or suggests having a light guide with a spherically shaped bottom surface and a plurality of the elements positioned

about the bottom surface at the preselected locations to direct scattering of the light rays in a particular way to form a symbol.

It is therefore respectfully submitted that **claim 11, and claims 12-14,** dependent on **claim 11**, distinguish patentably over Simms.

In addition, claim 14 calls for a cladding material disposed on the outside of the bottom surface that cooperates with the plurality of microstructures to effectuate the light scattering. It is alleged that Maas discloses a cladding disposed on surface 3 bearing the microstructures. Maas discloses that the deformities themselves are provided with the reflecting coating on a boundary surface. (Para. 0056, lines 12-14, claim 5, element 215 of fig. 3). Maas does not disclose or suggest providing a cladding on the outside of the bottom surface. Claim 14 discloses cladding of the bottom surface to prevent light from escaping the wave guide and scattering it in the preselected pattern. Therefore, claim 14 distinguishes patentably and unobviously over Maas and Simms, taken singularly or in combination.

Claim 16 has been written in independent form. **Claim 16** calls for a light emissive wave guide including a textured surface and defining a center and a perimeter, wherein a thickness of the light emissive wave guide at the perimeter is greater than a thickness of the light emissive wave guide at the center. A plurality of light producing elements is arranged around a perimeter of the wave guide. None of the references discloses or suggests an area light with the LEDs positioned around the perimeter of the wave guide, wherein the wave guide is thicker at the perimeter and thinner at the central portion.

It is therefore respectfully submitted that **claim 16, and claims 17-19,** dependent on **claim 16**, distinguish patentably all references.

CONCLUSION

On the basis of the above amendments and remarks, reconsideration of this application and its early allowance are requested.

Respectfully submitted,

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CERTIFICATE OF MAILING

I hereby certify that this **AMENDMENT A** in connection with U.S. Patent Application Serial No. 09/682,516 is being deposited with the United states Postal Service as first class mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450, on Friday, June 27, 2003.

By: Georgeen B. George

Amendments to the Abstract:

OPTICAL WAVE GUIDE

ABSTRACT OF THE DISCLOSURE

A lighting apparatus **(10)** includes a wave guide **(14)** formed from a translucent material. The wave guide has a top surface **(30)**, a bottom surface **(32)** that has a pre-defined curvature, and at least one side surface **(34)** that receives light **(40)** injected therein. A plurality of microstructures **(36)** ~~are~~ is arranged on selected areas of the bottom surface **(32)** of the wave guide **(14)**. The plurality of microstructures **(36)** cooperates with the pre-defined curvature of the bottom surface **(32)** to scatter at least a portion of the light **(40)** injected into the at least one side surface **(34)**. The scattered light **(42)** exits the wave guide **(14)** through the top surface **(30)**. At least one light emitting diode **(16)** injects light **(40)** into the at least one side surface **(34)** of the wave guide **(14)**. The scattered light **(42)** that exits the wave guide **(14)** forms at least one symbol viewable by an associated observer.